
Girder integration NSLS-II

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Poster paper

Girder integration NSLS-II

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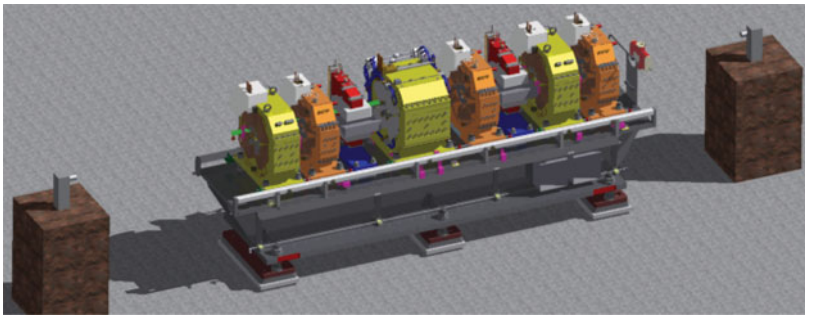
National Synchrotron Light Source II (NSLS-II) will be a 3-GeV 792 m circumference third generation synchrotron radiation facility with ultra low emittance and extremely high brightness. There will be a total of 90 multipole storage ring girders supporting the vacuum chambers, multipole magnets and various pieces of ancillary equipment. A major effort is being made to meet the stringent assembly and alignment requirements for the girder assemblies using relatively few and removable positioning fixtures. Girder assembly and alignment will be accomplished in four phases. Each of these phases will be described along with the fixtures required.



NSLS-II Alignment Tolerances
Magnet-to-Magnet (RMS): horizontal alignment, ±0.030 mm; vertical alignment, ±0.030 mm; roll angle, ±0.20 mrad.

1. Phase I

Magnets are placed on the girder using simple alignment hardware to within 500 μm of their final location. Each magnet is supported by four 1.25′ × 12 Threads Per Inch (TPI) threaded posts that mount into tapped holes on the top of the girder. Nuts with spherical washers above and below each magnet's base plate lock the magnets in position. Temporary machined spacers are used to

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vertically locate each magnet. Tapered nuts horizontally locate each magnet by centring the magnet's base plate mounting holes on their respective posts. An air bladder below the magnet removes a majority of magnets weight from the posts to simplify positioning.

2. Phase II

Magnets are positioned to within 200 μm of their final position using laser alignment tooling. Grouted pads with vertical and horizontal locating surfaces position each girder in a pre-alignment station. The girder mounts are tightened to its mounting pads to a torque of 250 foot-pounds. Pre-surveyed granite tables at the ends of the girder support a Hamar laser alignment system. Self-centring inserts with a laser target are positioned into the pole tips of each magnet and used to locate the magnet's centre, as well as pitch and yaw relative to the laser alignment tool. The longitudinal position of each magnet is measured using a laser tracker. A removable positioning fixture surrounds the magnets and includes adjustment screws for moving each magnet horizontally. This fixture maintains yaw during the final alignment phase. Six differential variable reluctance transducers (DVRTs) are attached to each magnet and used to measure the position of the magnet relative to the girder. Tooling ball mounting features machined into the tops of all magnets define a plane parallel to the magnet mid-plane within 0.1 mrad. Precision spirit levels mounted on removable interface plates and sitting on tooling balls measure the roll of each magnet to within 0.04 mrad.

199 Master Precision Level

Length Base		Width Base		Height Level			
Inch	mm	Inch	mm	Inch	mm	Catalog No.	EDP
15"	380mm	1-5/8"	40mm	3"	75mm	199Z	50719
						199Z W/SLC*	66932

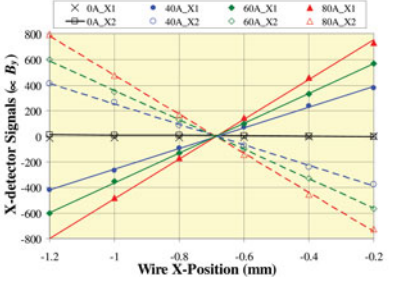
After all magnets are pre-aligned, the upper half of each magnet is removed and the vacuum chamber is installed. The vacuum chamber is assembled prior to installation with a temporary shield to protect the chamber's interior from contamination. Temporary fixtures and laser trackers are used to position the vacuum chamber to within 100 μm of its nominal position. The upper magnet halves are then reassembled and the girder assembly is moved into a thermally controlled final-alignment room where the temperature is held to better than ±0.1°C.

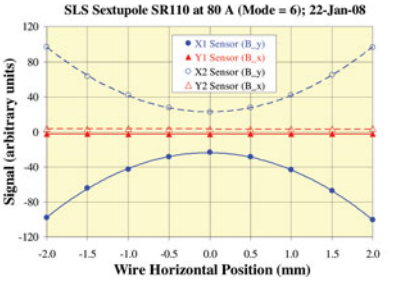
3. Phase III

Magnets are aligned to within 30 μm using a vibrating-wire technique (Jain, 2008). The pre-aligned girder assembly is positioned in the thermal room on similar pads and locating surfaces as in the pre-alignment station. The girder is again torqued down to 250 foot-pounds. As shown in the pictures below a 0.0125 mm dia. Cu–Be wire is stretched through the magnets, the magnets are energized sequentially while a sinusoidal current in passed through the wire. A pair of

wire vibration sensors at each end of the wire detects the motion as the wire is scanned horizontally and vertically across the centre of each magnet. Scans of quadrupole and sextupole magnets are shown below and have been able to derive the magnetic centre of magnets to 5 μm. The horizontal axis of each graph indicates the vibrating wire location in the transverse direction. The vertical axis indicates the vibrating wire's vibration amplitude and sensor's signal strength. With the magnetic axis located, each magnet is then moved to its required position using the DVRT mounted earlier. The mounting hardware is torqued to 200 foot-pounds. The final survey of the girder assembly is now performed.





4. Phase IV

The aligned girder assembly is removed from the thermal room and moved into a final assembly/bake-out area. The final assembly includes removal of positioning fixtures, alignment instrumentation and the vacuum chamber's temporary shield. Installation of vacuum pumps and final wiring (beam-positioning monitors, vacuum chamber thermocouples and bake-out heaters) completes the assembly. The vacuum chamber is sealed and a short bake-out is performed along with a final leak check.

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REFERENCE

JAIN, A. Vibrating wire R&D for alignment of multipole magnets in NSLS-II. In *The 10th International Workshop on Accelerator Alignment*, KEK, Tsukba (11–15 February 2008).